Title: UNIT-LAYER POST-PROCESSING CATALYST CHEMICAL-VAPOR-DEPOSITION APPARATUS AND ITS FILM FORMING METHOD
Inventor: Makiko KITAZOE et al
Appln No.: New Application
Atty. Docket No.: 101136-00131

FIG.1

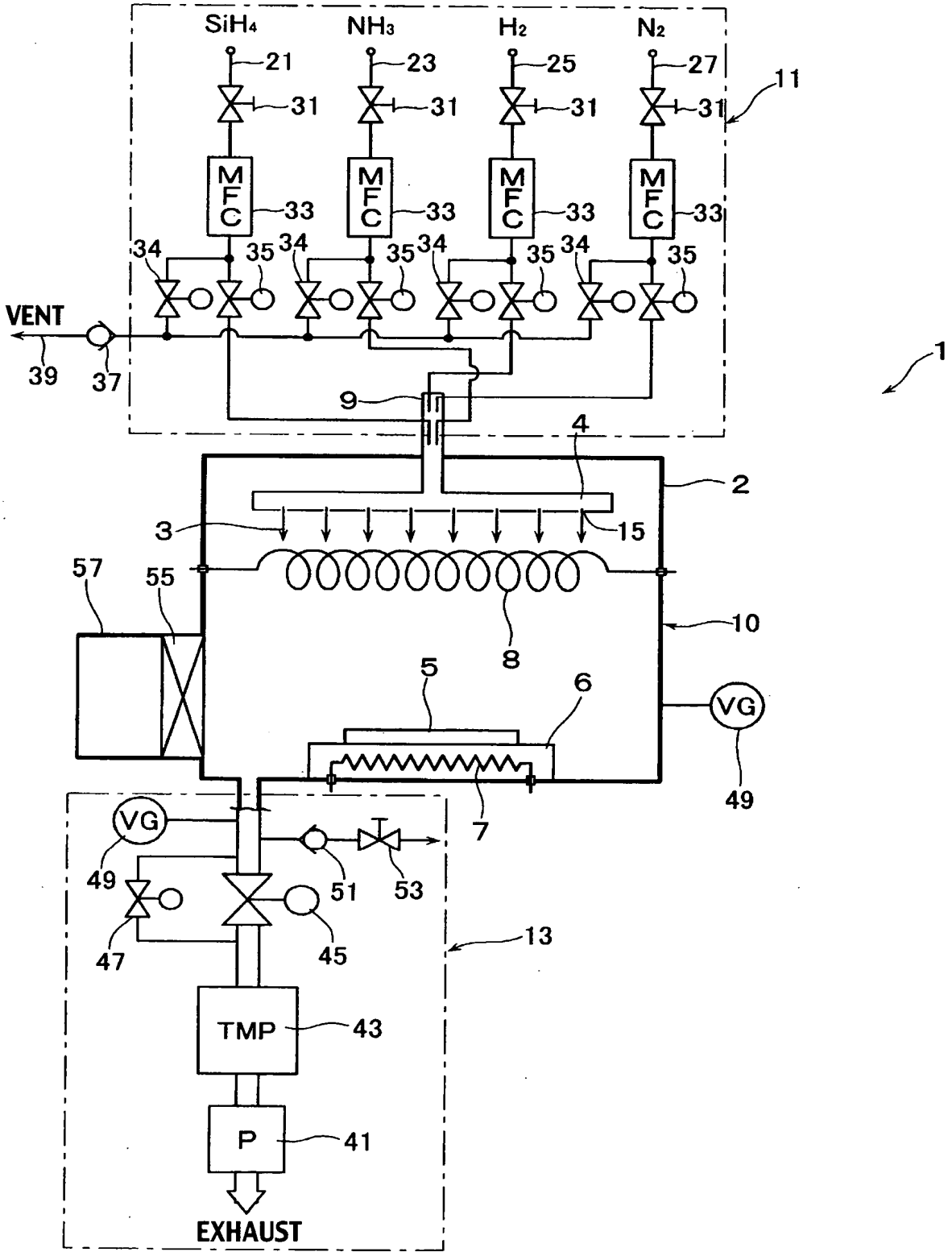


FIG.2 EXAMPLE OF GAS-SUPPLY TIMING CHART

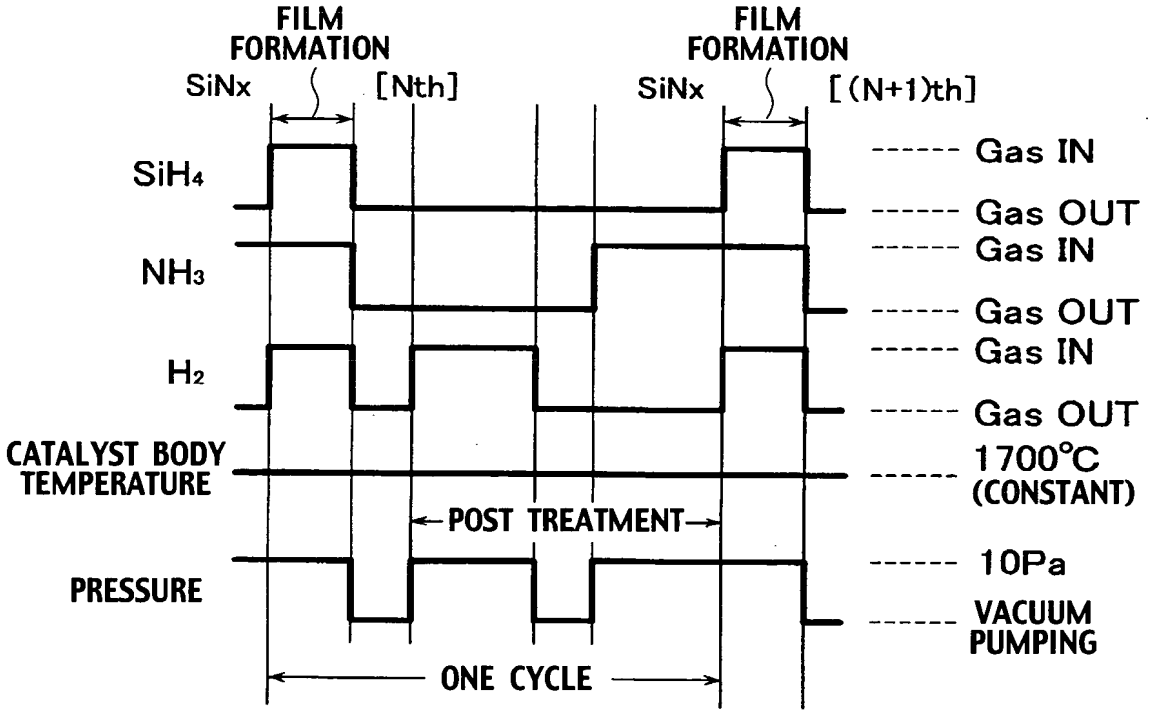


FIG.3 EXAMPLE OF GAS-SUPPLY TIMING CHART

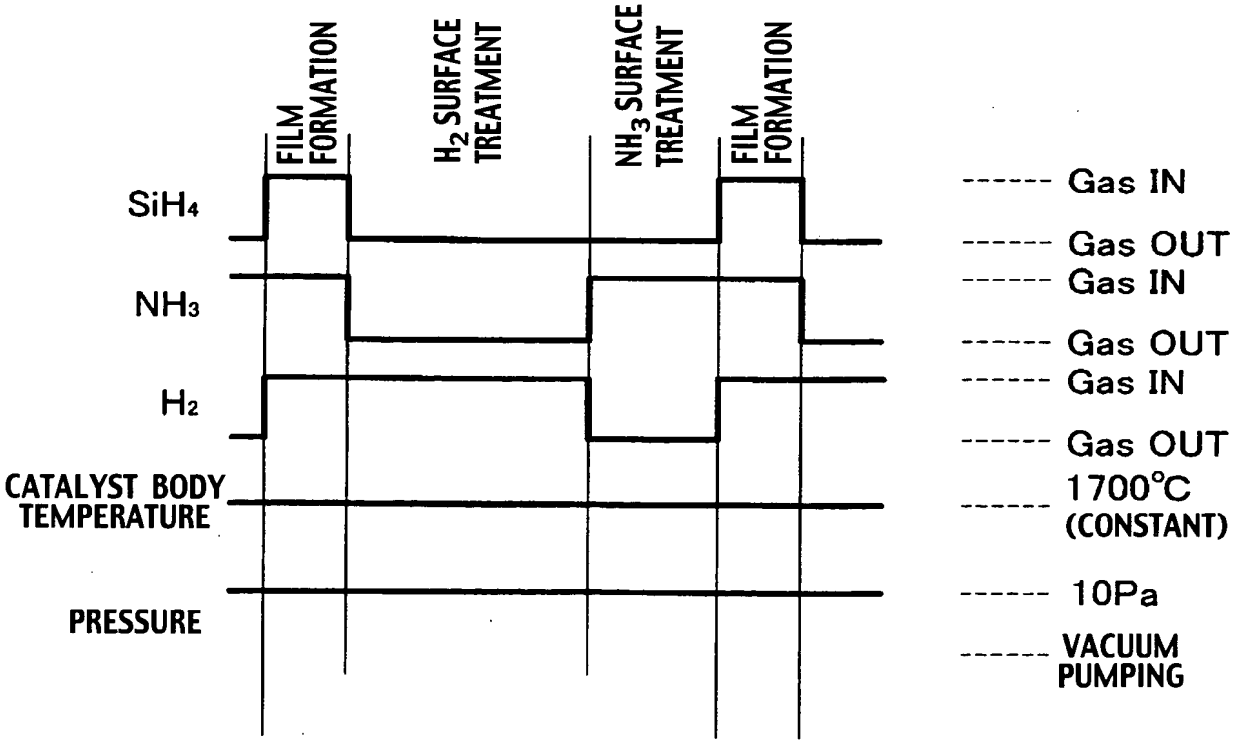


FIG.4 EXAMPLE OF GAS-SUPPLY TIMING CHART

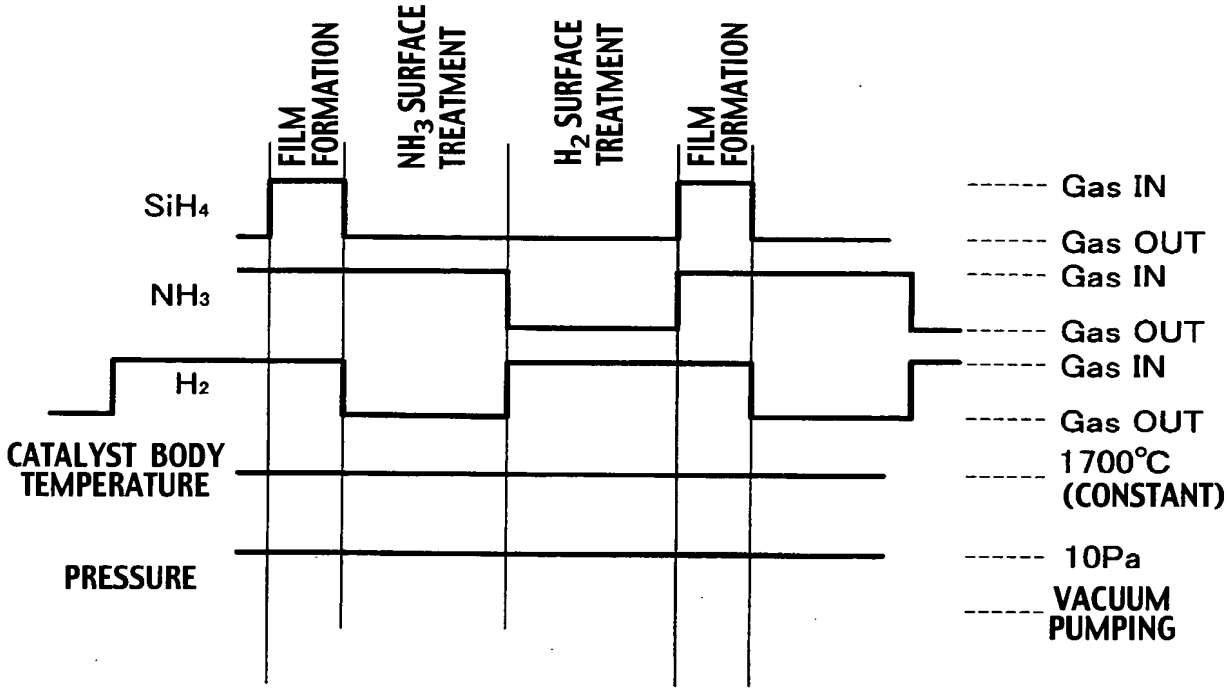


FIG.5 EXAMPLE OF GAS-SUPPLY TIMING CHART

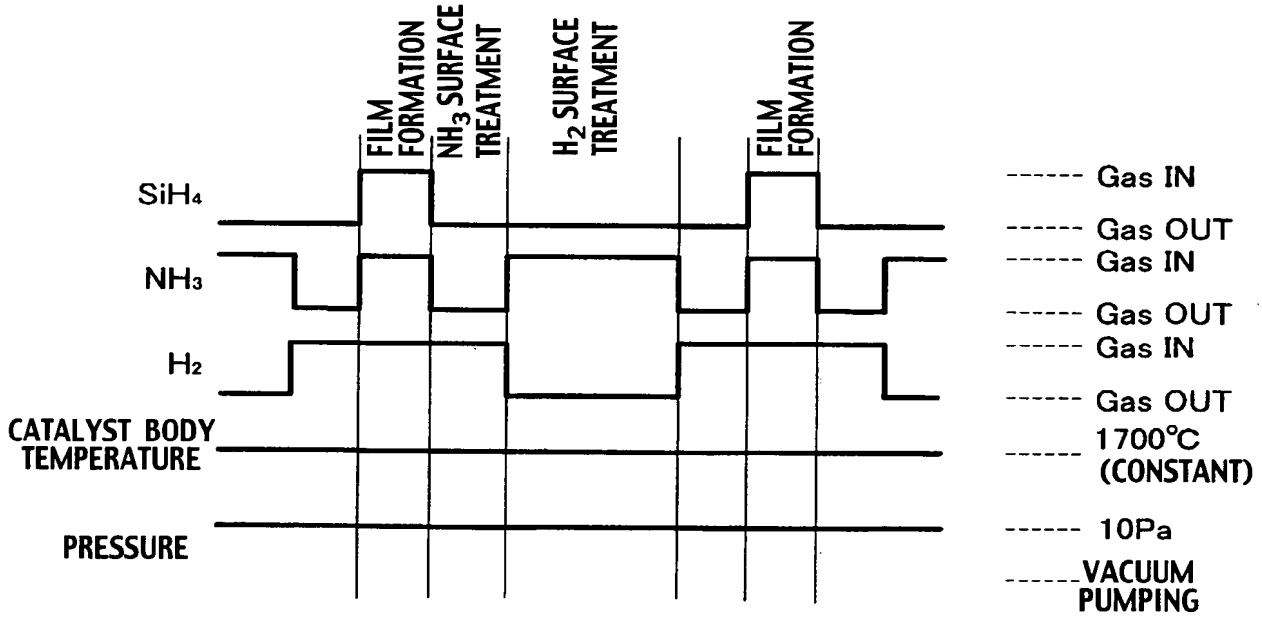


FIG.6 EXAMPLE OF GAS-SUPPLY TIMING CHART

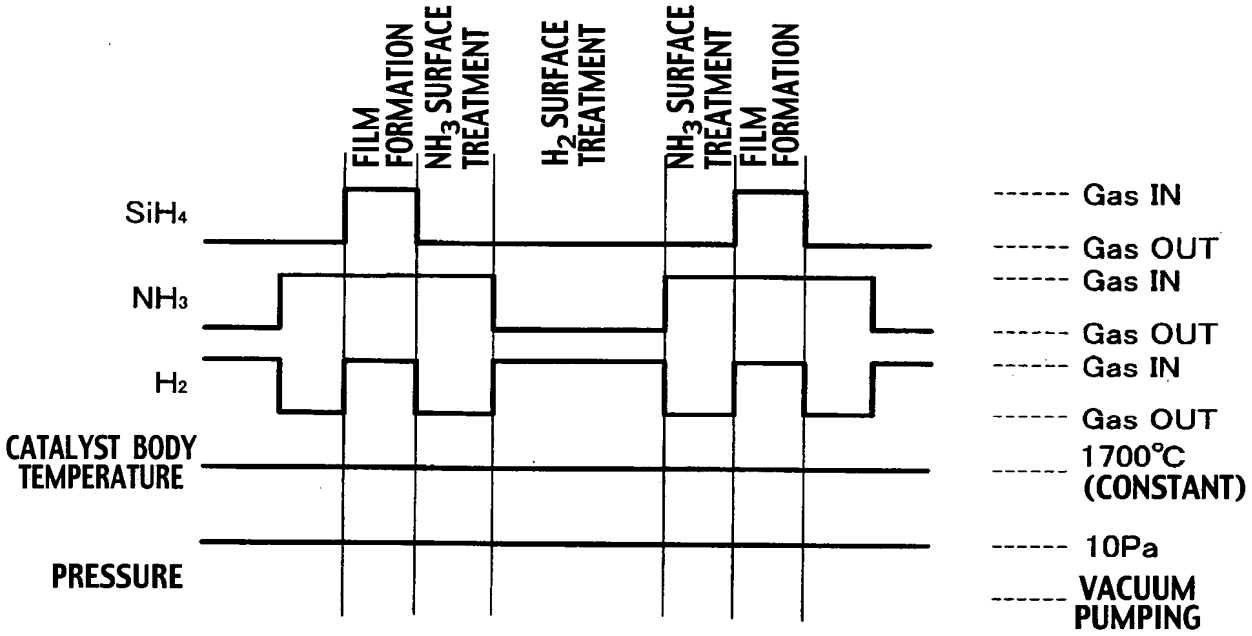


FIG.7 EXAMPLE OF GAS-SUPPLY TIMING CHART

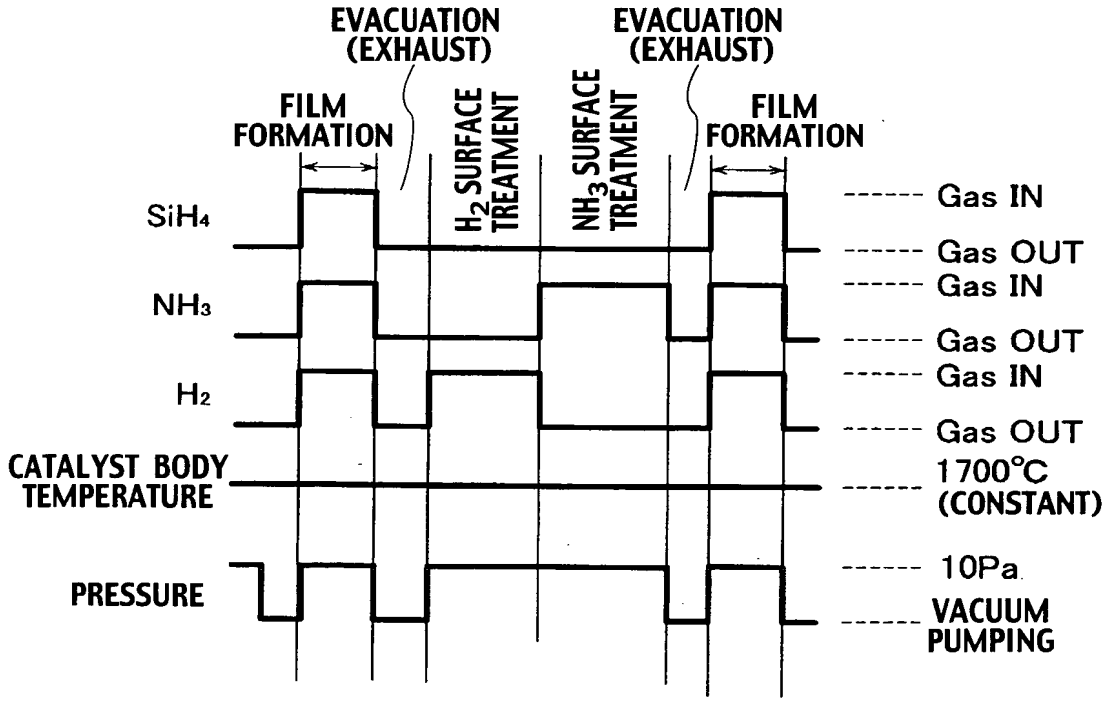


FIG.8 Cat-CVD STEP COVERAGE BY $SiH_4/NH_3/H_2$

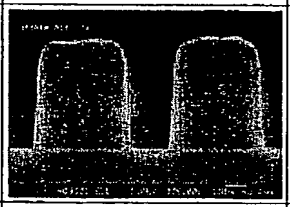
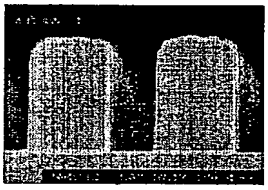
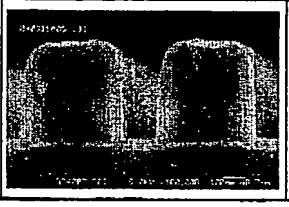
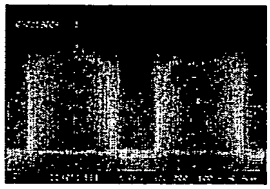
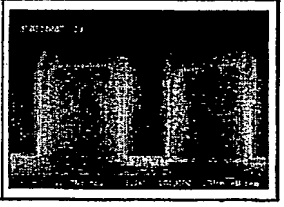
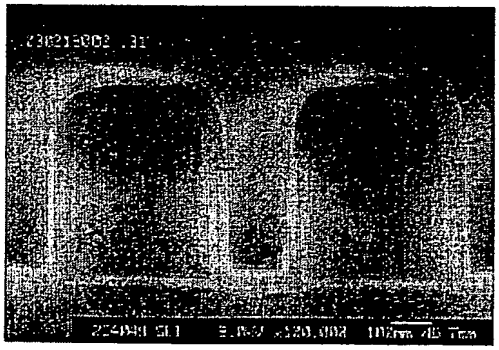
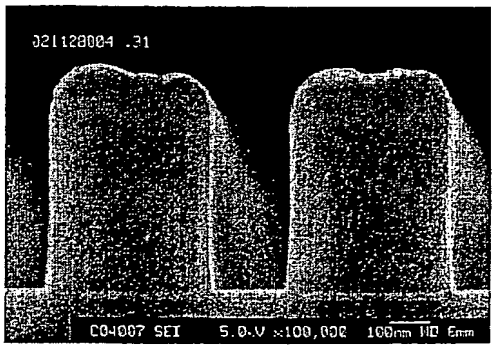
	NH_3 FLOW RATE [sccm] *($SiH_4/NH_3/H_2$=[7/10/(VARIABLE)]sccm, 10Pa)*			
	0	10	15	30
300°C	—		—	—
100°C				

FIG.9 COMPARISON BETWEEN ADDITIVE GASES OF COVERAGE



$SiH_4/NH_3/H_2$



$SiH_4/NH_3/N_2$

FIG.10

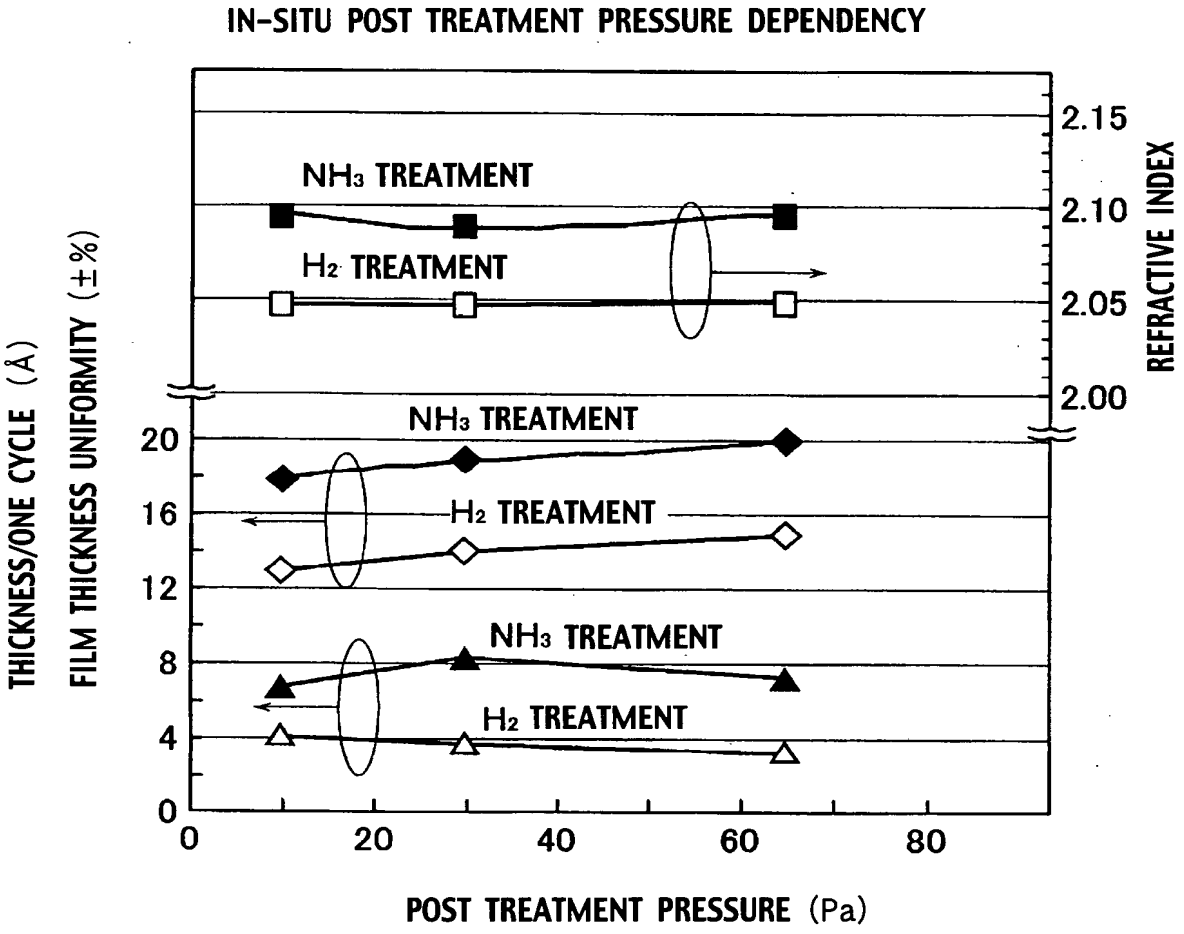

IN-SITU POST TREATMENT PRESSURE DEPENDENCY
NH3 TREATMENT
H2 TREATMENT
NH3 TREATMENT
H2 TREATMENT
NH3 TREATMENT
H2 TREATMENT
2.15
2.10
2.05
2.00
REFRACTIVE INDEX
20
16
12
8
4
0
THICKNESS/ONE CYCLE (Å)
FILM THICKNESS UNIFORMITY (±%)
0
20
40
60
80
POST TREATMENT PRESSURE (Pa)

FIG.11 H_2 TREATMENT EFFECT AT COMPOSITE POST TREATMENT

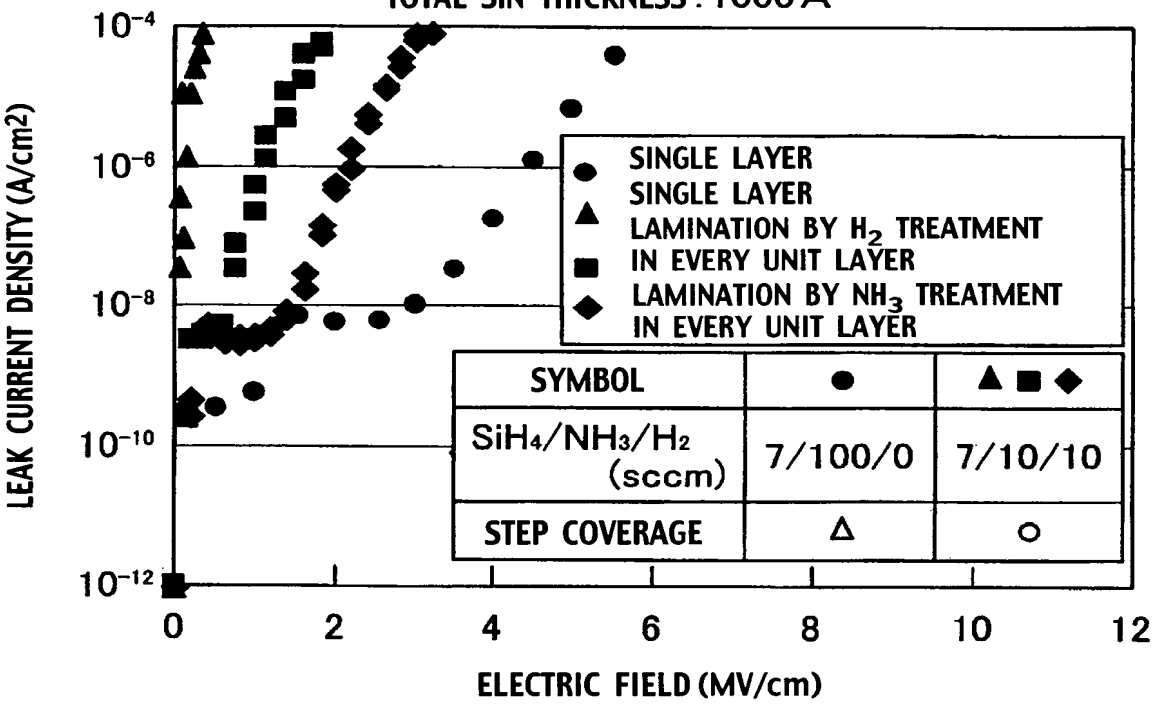


FIG.12 GAS ATMOSPHERE DEPENDENCY AT COMPOSITE POST TREATMENT

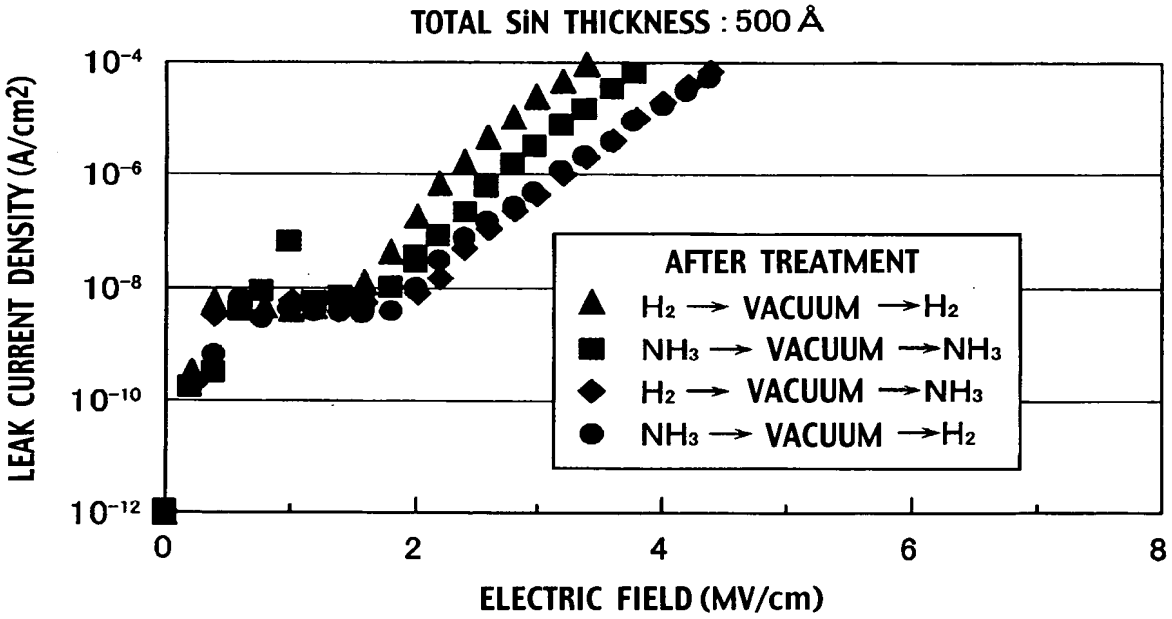


FIG.13 UNIT-FILM THICKNESS DEPENDENCY OF LAYERED CAT-SiN FILM

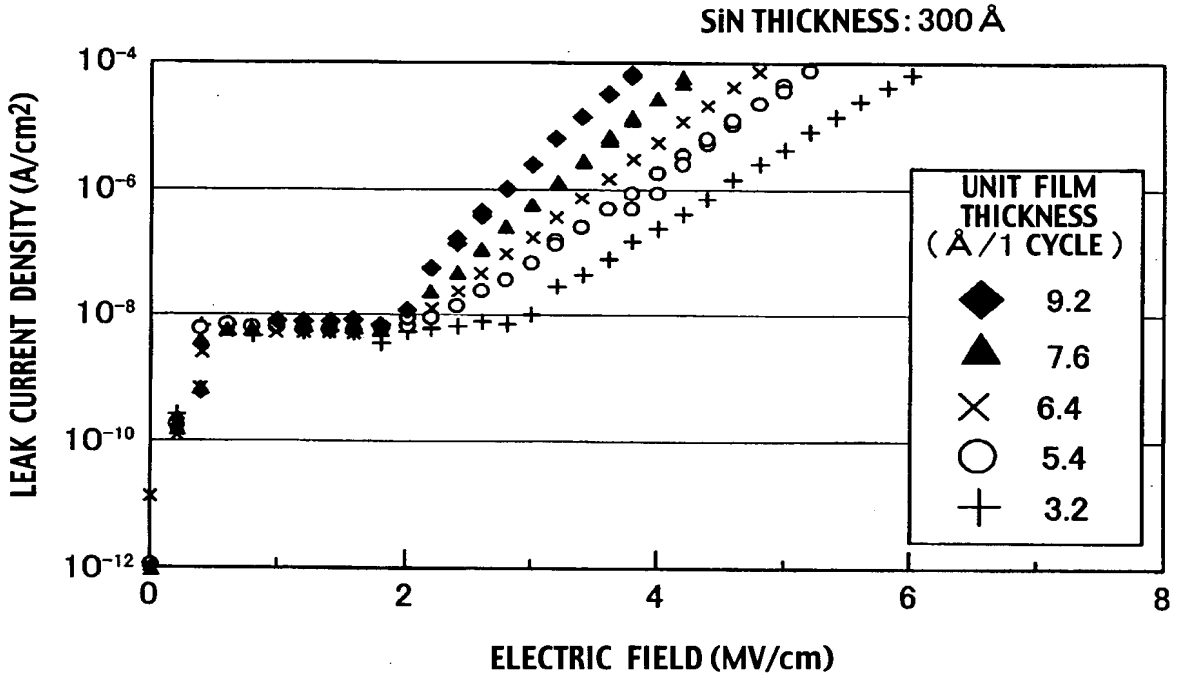


FIG.14 COMPOSITION RATIO OF SiN FILM BY NH_3 RESTRAINED $SiH_4/NH_3/H_2$

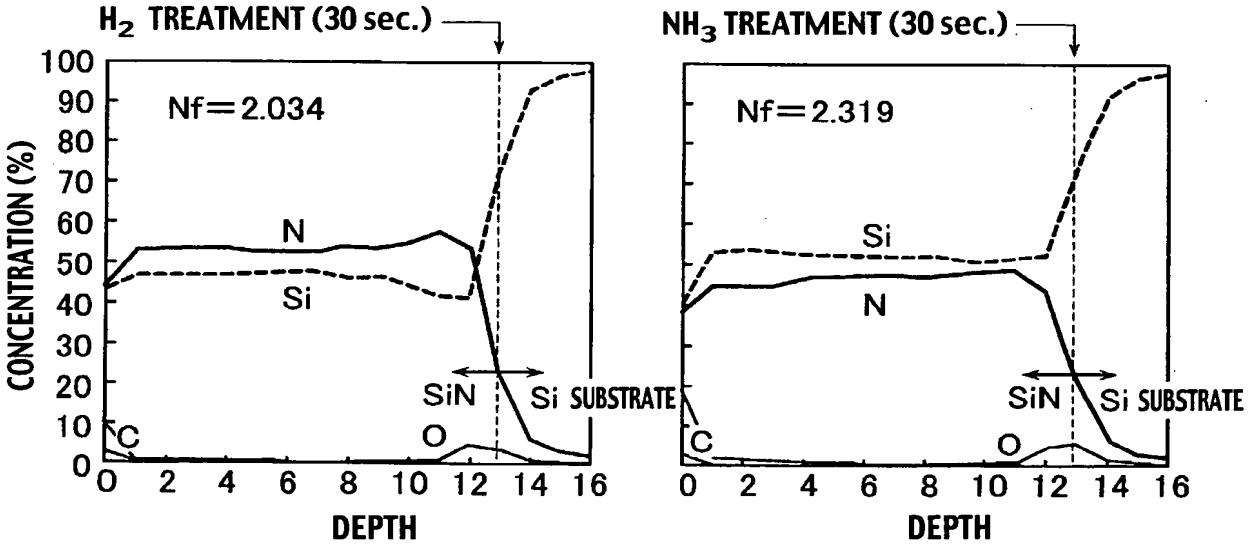
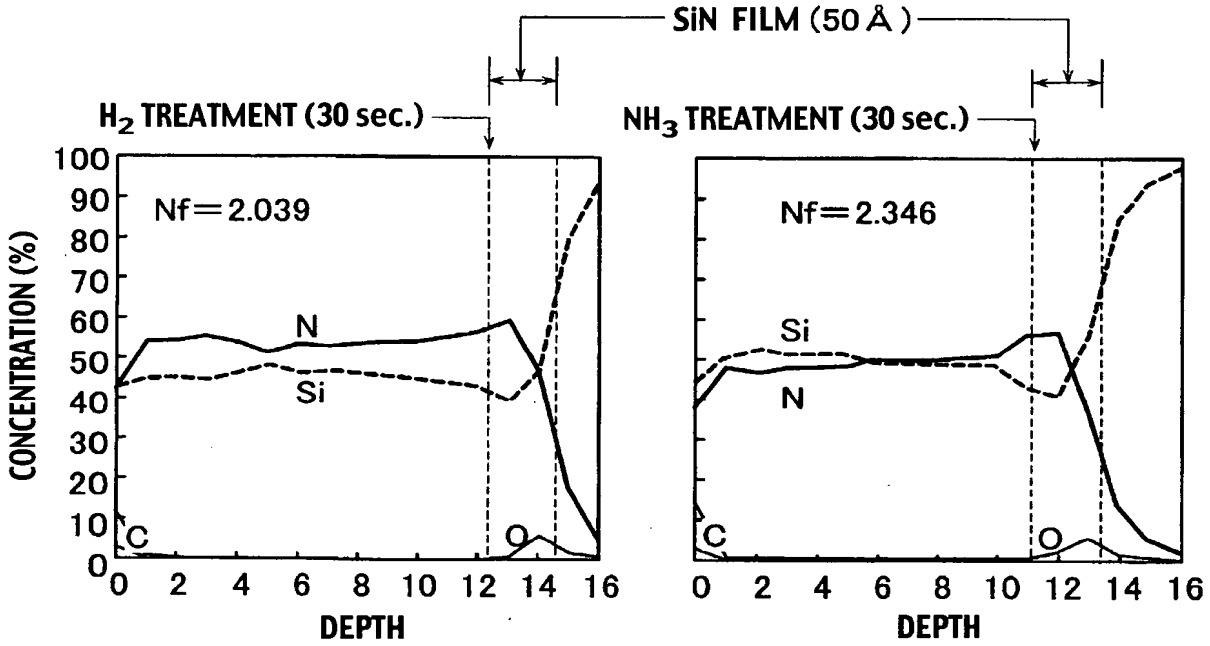


FIG. 15 COMPOSITION RATIO OF SiN FILMS BY NH_3 RESTRAINED $SiH_4/NH_3/H_2$



(a) ON H_2 PRECEDENT INTRODUCTION SiNx (b) ON NH_3 PRECEDENT INTRODUCTION SiNx

FIG. 16

GAS IRRADIATION SEQUENCE DEPENDENCY AT in-situ POST TREATMENT

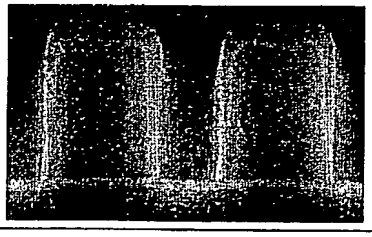
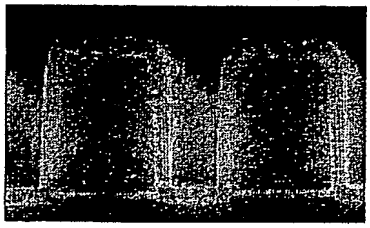
GAS	NH_3	H_2	POSTTREATMENT
GAS	H_2	NH_3	PRETREATMENT
STEP COVERAGE			
REFRACTIVE INDEX	2.05	2.05	

FIG.17 HYDROGEN CONTENT IN Cat-SiN FILM

	Si-H (cm^{-3})	N-H (cm^{-3})	TOTAL-H (cm^{-3})
SINGLE LAYER Cat-SiN	3×10^{21}	4×10^{21}	7×10^{21}
LAMINATED Cat-SiN BY POST TREATMENT IN EVERY UNIT LAYER	2×10^{21}	5×10^{20}	2×10^{21}
PECVD-SiN	6×10^{21}	1×10^{22}	2×10^{22}

500Å-THICKNESS Cat-SiN (100℃)

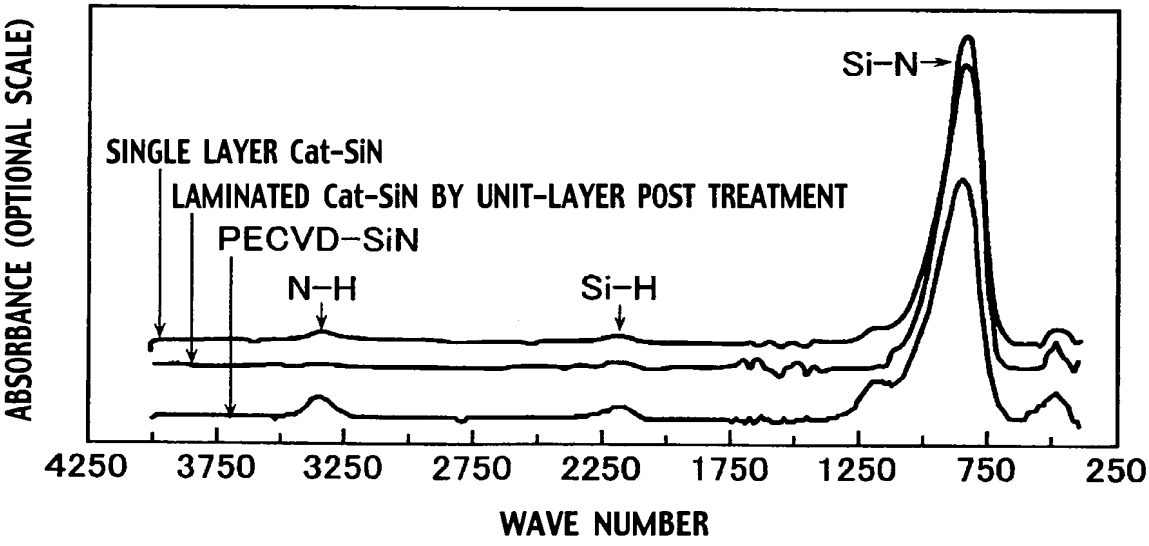


FIG.18 COMPARISON OF HYDROGEN CONTENT OF EACH Cat-SiN FILM

SUPPLY GAS (sccm)			THIN FILM STRUCTURE	Si-H (cm^{-3})	N-H (cm^{-3})	TOTAL-H (cm^{-3})
SiH_4	NH_3	H_2				
7	100	—	SINGLE LAYER	2.4×10^{21}	3.6×10^{21}	6×10^{21}
↑	10	10		1.1×10^{22}	2.3×10^{21}	1.3×10^{22}
↑	100	—	POST TREATMENT IN EVERY UNIT LAYER	1.1×10^{21}	5.7×10^{21}	6.8×10^{21}
↑	10	10		9.2×10^{20}	1.3×10^{21}	2.2×10^{21}

FIG.19

	CONVENTIONAL METHOD	METHOD OF PRESENT INVENTION
SiH_4(sccm)	7	7
NH_3(sccm)	10	10
H_2(sccm)	10	10
PRESSURE (Pa)	10	10
CATALYST BODY TEMPERATURE (°C)	1700	1700
FILM THICKNESS OF ONE-TIME FILM FORMATION (nm)	50	1
NUMBER OF REPETITIONS (TIMES)	1	50
ONE SURFACE TREATING STEP	NONE	H_2
OTHER SURFACE TREATING STEP	NONE	NH_3

FIG.20

	CONVENTIONAL METHOD	METHOD OF PRESENT INVENTION
SiH_4(sccm)	7	7
NH_3(sccm)	10	10
H_2(sccm)	10	10
PRESSURE (Pa)	10	10
CATALYST BODY TEMPERATURE (°C)	1700	1700
FILM THICKNESS OF ONE-TIME FILM FORMATION (nm)	100	1
NUMBER OF REPETITIONS (TIMES)	1	100
ONE SURFACE TREATING STEP	NONE	H_2
OTHER SURFACE TREATING STEP	NONE	NH_3

FIG.21

	CONVENTIONAL METHOD	METHOD OF PRESENT INVENTION
SIDE COVERAGE (%)	70	72
BOTTOM COVERAGE (%)	87	90
I-V WITHSTAND VOLTAGE PROPERTIES (MV/cm)	0.1	4.8

FIG.22

	CONVENTIONAL METHOD	METHOD OF PRESENT INVENTION
SiH_4(sccm)	7	7
NH_3(sccm)	100	10
H_2(sccm)	0	10
PRESSURE (Pa)	10	10
CATALYST BODY TEMPERATURE (°C)	1700	1700
FILM THICKNESS OF ONE-TIME FILM FORMATION (nm)	100	1
NUMBER OF REPETITIONS (TIMES)	1	100
ONE SURFACE TREATING STEP	NONE	H_2
OTHER SURFACE TREATING STEP	NONE	NH_3

FIG.23

	CONVENTIONAL METHOD	METHOD OF PRESENT INVENTION
IN-PLANE UNIFORMITY (±%)	10	4
ETCHING RATE (nm/min)	6	2